FINAL REPORT

SUPERCONDUCTING MAGNET

CONTRACT NUMBER NAS5-28627
NASA GODDARD SPACE FLIGHT CENTER
GREENBELT, MARYLAND 20771

BY

CRYOMAGNETICS, INC.
P. O. BOX 548
OAK RIDGE, TENNESSEE 37831

CONTENTS

1.0 SUMMARY OF WORK

Extensive computer-based engineering design effort resulted in optimization of a superconducting magnet design with an average bulk current density of approximately 12KA/cm^2. Twisted, stranded 0.0045 inch diameter NbTi superconductor in a copper matrix was selected. Winding the coil from this bundle facilitated uniform winding of the small diameter wire.

Test coils were wound using a first lot of the wire. The actual packing density was measured from these. Interwinding voltage break down tests on the test coils indicated the need for adjustment of the wire insulation on the lot of wire subsequently ordered for construction of the delivered superconducting magnet.

Using the actual packing densities from the test coils, a final magnet design, with the required enhancement and field profile, was generated. All mechanical and thermal design parameters were then also fixed.

The superconducting magnet was then fabricated and tested. The first test was made with the magnet immersed in liquid helium at 4.2K. The second test was conducted at 2K in vacuum. In the latter test, the magnet was conduction cooled from the mounting flange end.

All test procedures and results are documented herein.

2.0 RECOMMENDED PRECAUTIONS IN USE OF THE SUPERCONDUCTING MAGNET

The superconducting magnet delivered represents a real advance in a specialized area of superconducting magnet technology. Please recognize that it is a first-of-a-kind unit.

As such, the magnet has been designed strictly to reach the performance objectives stated in this contract. Use outside of these performance bounds could result in destruction of the magnet.

Please observe the following precautions:

1. DO NOT OPERATE THE MAGNET IN EXCESS OF THE 3.0 AMPS CURRENT AND 1.0 VOLTS CHARGING VOLTAGE SHOWN IN TABLE CMI-2, "SUPERCONDUCTING MAGNET TEST RESULTS".
2. BE CERTAIN TO USE LARGE DIAMETER SUPERCONDUCTOR FOR CURRENT LEADS, AND FIRMLY HEAT SINK THESE LEADS TO 2K.
3. DO NOT DROP THE MAGNET.
4. DO NOT DRILL ANY HOLES IN THE MAGNET STRUCTURE WITHOUT CHECKING FIRST WITH CRYOMAGNETICS.
5. DO NOT OPERATE THE MAGNET ABOVE 4.2K.
6. BE SURE TO ALLOW THE MAGNET TO REACH FULL THERMAL EQUILIBRIUM BEFORE OPERATION AT 2K. ALLOW ONE HOUR FOR SAFETY.

3.0 MAGNET SPECIFICATIONS, LAYOUT DRAWING

The magnetic field specification is tabulated in Table CMI-1. The layout drawing, CMI Engineering Drawing Number CMI-1029, follows.

TABLE CMI-1

CRYOMAGNETICS, INC.

NASA - GODDARD SUPERCONDUCTING SOLENOID

ARTICLE B-1, ITEM 2

ANTICIPATED FINAL AXIAL FIELD PROFILE

28 JANUARY 1985

- COORDINATES -		-- MAGNETIC FIELD -		
RHO	Z	BR	BZ	BMOD
(CM)			(GAUSS)	
.0000E+00	-2.0000E+01	.0000E+00	[illegible]	[illegible]
.0000E+00	-1.9000E+01	.0000E+00	[illegible]	[illegible]
.0000E+00	-1.8000E+01	.0000E+00	4.3520E+02	4.3520E+02
.0000E+00	-1.7000E+01	.0000E+00	5.[illegible]85E+02	5.[illegible]5E+02
.0000E+00	-1.6000E+01	.0000E+00	7.[illegible]3[illegible]E+02	7.[illegible]336E+02
.0000E+00	-1.5000E+01	.0000E+00	8.7750E+02	8.7750E+02
.0000E+00	-1.4000E+01	.0000E+00	1.0717E+03	1.0717E+03
.0000E+00	-1.3000E+01	.0000E+00	1.3885E+03	1.3885E+03
.0000E+00	-1.2000E+01	.0000E+00	1.8021E+03	1.8021E+03
.0000E+00	-1.1000E+01	.0000E+00	2.3917E+03	2.3917E+03
.0000E+00	-1.0000E+01	.0000E+00	3.2546E+03	3.2546E+03
.0000E+00	-9.0000E+00	.0000E+00	4.5466E+03	4.5466E+03
.0000E+00	-8.0000E+00	.0000E+00	6.5095E+03	6.5095E+03
.0000E+00	-7.0000E+00	.0000E+00	9.4617E+03	9.4617E+03
.0000E+00	-6.0000E+00	.0000E+00	1.3615E+04	1.3615E+04
.0000E+00	-5.0000E+00	.0000E+00	1.8570E+04	1.8570E+04
.0000E+00	-4.0000E+00	.0000E+00	2.3173E+04	2.3173E+04
.0000E+00	-3.0000E+00	.0000E+00	2.6556E+04	2.6556E+04
.0000E+00	-2.0000E+00	.0000E+00	2.8658E+04	2.8658E+04
.0000E+00	-1.0000E+00	.0000E+00	2.9736E+04	2.9736E+04
.0000E+00	.0000E+00	.0000E+00	2.9997E+04	2.9997E+04
.0000E+00	1.0000E+00	.0000E+00	2.9502E+04	2.9502E+04
.0000E+00	2.0000E+00	.0000E+00	2.8160E+04	2.8160E+04
.0000E+00	3.0000E+00	.0000E+00	2.5730E+04	2.5730E+04
.0000E+00	4.0000E+00	.0000E+00	2.1923E+04	2.1923E+04
.0000E+00	5.0000E+00	.0000E+00	1.6784E+04	1.6784E+04
.0000E+00	6.0000E+00	.0000E+00	1.1215E+04	1.1215E+04
.0000E+00	7.0000E+00	.0000E+00	6.4843E+03	6.4843E+03
.0000E+00	8.0000E+00	.0000E+00	3.1603E+03	3.1603E+03
.0000E+00	9.0000E+00	.0000E+00	1.1604E+03	1.1604E+03
.0000E+00	1.0000E+01	.0000E+00	1.7551E+02	1.7551E+02
.0000E+00	1.1000E+01	.0000E+00	-1.5279E+02	1.5279E+02
.0000E+00	1.2000E+01	.0000E+00	1.5209E+02	1.5209E+02
.0000E+00	1.3000E+01	.0000E+00	4.7382E+01	4.7382E+01
.0000E+00	1.4000E+01	.0000E+00	5.4487E+01	5.4487E+01
.0000E+00	1.5000E+01	.0000E+00	1.2247E+02	1.2247E+02
.0000E+00	1.6000E+01	.0000E+00	1.6120E+02	1.6120E+02
.0000E+00	1.7000E+01	.0000E+00	1.7691E+02	1.7691E+02
.0000E+00	1.8000E+01	.0000E+00	1.7898E+02	1.7898E+02
.0000E+00	1.9000E+01	.0000E+00	1.7331E+02	1.7331E+02
.0000E+00	2.0000E+01	.0000E+00	1.6363E+02	1.6363E+02

NOTES:
1) FINAL FIELD PROFILE DATA ASSUMES OPERATING CURRENT OF 2.75 AMPERES TO ALLOW FOR POSSIBLE VARIATIONS IN FINAL WINDING PACKING DENSITY.
2) TOP OF COIL (NULL COIL SIDE) IS AT Z = 11.4 CM.
3) BOTTOM OF COIL (COLD FINGER MOUNTING PLATE SIDE) IS AT Z = -6.509 CM.
4) 3 INCH LONG REGION IN WHICH FIELD IS [illegible] 2.25 TESLA IS WHERE -4.00 CM [illegible] Z [illegible] 3.62 CM ([illegible] = -0.19 CM).
5) REGION WHERE FIELD IS [illegible] 1% OF Bmax (I.E., [illegible]300 G) IS FOR Z [illegible] 10.0 CM.

4.0 APPROVED TEST PLAN

The Factory Inspection Test Plan is delineated on the following page. The test apparatus for the 2K, vacuum test of the magnet is shown in Engineering Drawing Number CMI-1010.

Article B-1, Item 4

FACTORY INSPECTION TEST PLAN

1. The superconducting magnet will be operated and tested in the 2K and Vacuum SC Magnet Test Unit shown in Cryomagnetics Engineering Drawing Number CMI-1010. The referenced drawing is attached.

2. The magnet operating temperature during the tests will be monitored in each end flange. Carbon glass temperature sensors calibrated to NBS transfer standards to within 0.1K (1.4K to 6.0K) will be used.

3. All measurements will be made using techniques routinely employed in measurements on superconducting magnets. The following magnet parameters measurements will be made:

   3.A. Axial Field Profile. A continuous plot of axial field profile will be measured with an x-y recorder print out. Measurement accuracy of axial field will be better than 1:10exp4. Data will be taken from 4 inches outside of each flange, through the entire solenoid.

   3.B. Inductance. The magnet inductance will be measured with a ±1% accuracy.

   3.C. Charging Voltage. The magnet will be charged to full field at charging voltages from 0.25 Volts to 1.0 Volts in 0.25 Volts increments.

   3.D. Room Temperature Resistance. The room temperature resistance of the magnet will be measured with an accuracy of ±5%.

   3.E. Current vs. Peak Central Field. The coil constant calculated to ±1% from actual winding data will be used to measure the magnet current required to achieve 3.0 Tesla peak central field. The magnet will be operated at the current corresponding to 0 to 3.0 Tesla.

   3.F. Mechanical Dimension Verification. Mechanical inspection and measurements of all mechanical dimensions by the completed magnet will be made to an accuracy of $\pm 10^{-3}$ inches.

5.0 CERTIFIED TEST RESULTS

The Certified Test Results for the superconducting magnet are tabulated in Tables CMI-2, CMI-3.

The test results tabulated in Tables CMI-2, CMI-3 are certified below:

Certified By:

D. Michael Coffey
Vice-President for Engineering

TABLE CMI-2
SUPERCONDUCTING MAGNET TEST RESULTS
SERIAL NUMBER C-121-M
NASA/GODDARD SPACE FLIGHT CENTER
CONTRACT NUMBER NAS5-28627
MARCH 22, 1985

Rated Central Field	30 Kilogauss Using 2.0K Cold Finger Attachment in Vacuum
Maximum Test Field	30.6 Kilogauss Using 2.0K Cold Finger Attachment in Vacuum
Rated Current	2.992 Amperes
Field to Current Ratio	10.025 Kilogauss/Ampere
Homogeneity	$\|B\| \geq$ 22.5 Kilogauss for $-1.50 \leq z \leq 1.50$" Centered at 2.503" from the Cold Finger End of the Magnet
Compensation	$\|B\| \leq$ 1.5 Kilogauss (5% of B peak) for $z \geq$ 6.503" Relative to the Cold Finger End of the Magnet (4.00" from B peak)
Inductance	~ 332 Henries
Maximum Charging Voltage Used in Test	0.5 Volts
Room Temperature Magnet Resistance	~ 93K
Outside Diameter of Magnet	4 500 Inches
Outside Diameter of Cold Finger Attachment	6 000 Inches
Overall Length	6.898 Inches
Weight	~ 10 2 Pounds
Mounting Holes	As Per NASA Approved Drawing # CMI-1029

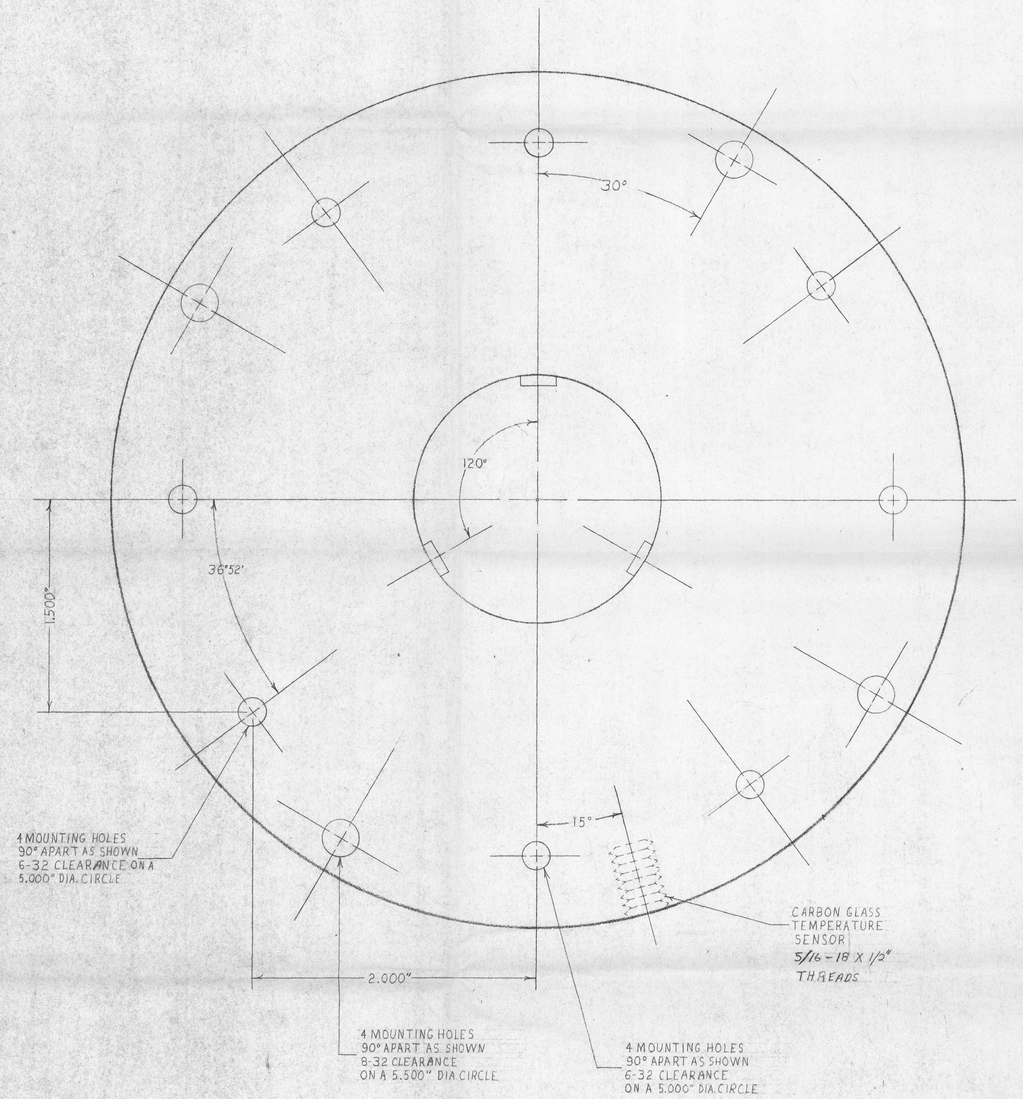
CRYOMAGNETICS INC.
NASA - GODDARD SUPERCONDUCTING SOLENOID

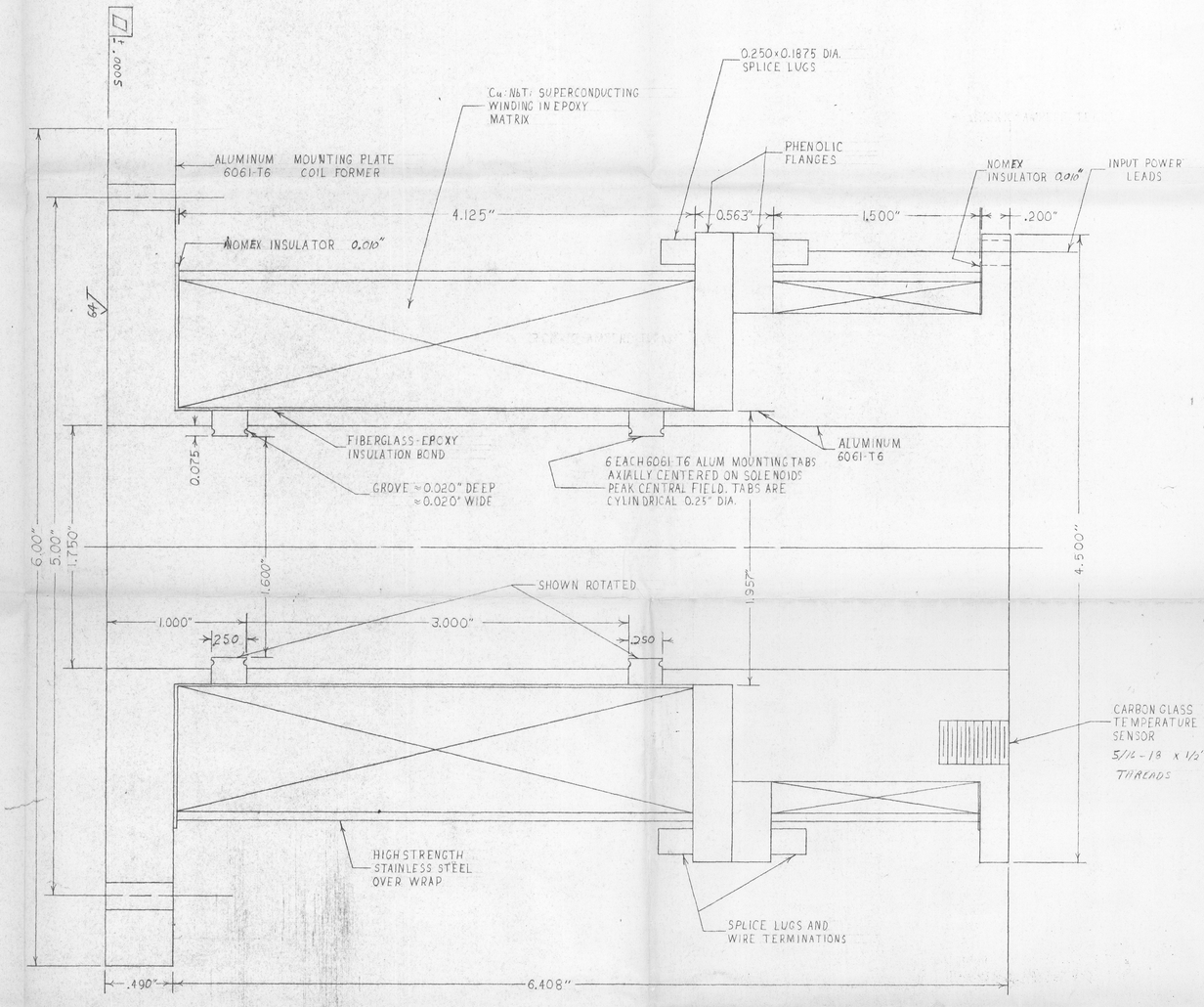
TABLE CMI-3

TRUE AXIAL FIELD PROFILE AS PER FINAL WINDING DATA
21 MARCH 1985

- COORDINATES -		- MAGNETIC FIELD -		
RHO	Z	BR	BZ	BMOD
(CM)			(GAUSS)	
.0000E+00	-2.0000E+01	.0000E+00	[illegible]	[illegible]
.0000E+00	-1.9000E+01	.0000E+00	4.4630E+03	4.4630E+03
.0000E+00	1.8000E+01	.0000E+00	[illegible]	[illegible]
.0000E+00	1.7000E+01	.0000E+00	[illegible]	[illegible]
.0000E+00	-1.6000E+01	.0000E+00	[illegible]	[illegible]
.0000E+00	-1.5000E+01	.0000E+00	9.4754E+03	9.4754E+03
.0000E+00	-1.4000E+01	.0000E+00	1.1813E+04	1.1813E+04
.0000E+00	-1.3000E+01	.0000E+00	1.4908E+04	1.4908E+04
.0000E+00	-1.2000E+01	.0000E+00	[illegible]	[illegible]
.0000E+00	-1.1000E+01	.0000E+00	[illegible]	[illegible]
.0000E+00	1.0000E+01	.0000E+00	[illegible]	[illegible]
.0000E+00	-9.0000E+00	.0000E+00	[illegible]	[illegible]
.0000E+00	-8.0000E+00	.0000E+00	[illegible]	[illegible]
.0000E+00	-7.0000E+00	.0000E+00	[illegible]	[illegible]
.0000E+00	-6.0000E+00	.0000E+00	[illegible]	[illegible]
.0000E+00	-5.0000E+00	.0000E+00	[illegible]	[illegible]
.0000E+00	-4.0000E+00	.0000E+00	[illegible]	[illegible]
.0000E+00	-3.0000E+00	.0000E+00	[illegible]	[illegible]
.0000E+00	-2.0000E+00	.0000E+00	[illegible]	[illegible]
.0000E+00	-1.0000E+00	.0000E+00	[illegible]	[illegible]
.0000E+00	.0000E+00	.0000E+00	[illegible]	[illegible]
.0000E+00	1.0000E+00	.0000E+00	[illegible]	[illegible]
.0000E+00	2.0000E+00	.0000E+00	[illegible]	[illegible]
.0000E+00	3.0000E+00	.0000E+00	[illegible]	[illegible]
.0000E+00	4.0000E+00	.0000E+00	[illegible]	[illegible]
.0000E+00	5.0000E+00	.0000E+00	1.6974E+04	1.6974E+04
.0000E+00	6.0000E+00	.0000E+00	[illegible]	[illegible]
.0000E+00	7.0000E+00	.0000E+00	[illegible]	[illegible]
.0000E+00	8.0000E+00	.0000E+00	[illegible]	[illegible]
.0000E+00	9.0000E+00	.0000E+00	[illegible]	[illegible]
.0000E+00	1.0000E+01	.0000E+00	[illegible]	[illegible]
.0000E+00	1.1000E+01	.0000E+00	[illegible]	[illegible]
.0000E+00	1.2000E+01	.0000E+00	[illegible]	[illegible]
.0000E+00	1.3000E+01	.0000E+00	[illegible]	[illegible]
.0000E+00	1.4000E+01	.0000E+00	[illegible]	[illegible]
.0000E+00	1.5000E+01	.0000E+00	[illegible]	[illegible]
.0000E+00	1.6000E+01	.0000E+00	[illegible]	[illegible]
.0000E+00	1.7000E+01	.0000E+00	[illegible]	[illegible]
.0000E+00	1.8000E+01	.0000E+00	[illegible]	[illegible]
.0000E+00	1.9000E+01	.0000E+00	[illegible]	[illegible]
.0000E+00	2.0000E+01	.0000E+00	[illegible]	[illegible]
-	-	-	-	-
.0000E+00	-2.0000E+01	.0000E+00	[illegible]	[illegible]
.0000E+00	-1.7500E+01	.0000E+00	[illegible]	[illegible]
.0000E+00	1.5000E+01	.0000E+00	[illegible]	[illegible]
.0000E+00	1.2500E+01	.0000E+00	[illegible]	[illegible]
.0000E+00	-1.0000E-01	.0000E+00	[illegible]	[illegible]

NOTES:
1) TRUE FIELD PROFILE DATA ABOVE ASSUMES OPERATING CURRENT OF 2.992 AMPERES.
2) TOP OF COIL (NOTE COIL SIDE) IS AT Z = 11.01 CM.
3) BOTTOM OF COIL (COLD FINGER MOUNTING PLATE SIDE) IS AT Z = -6.509 CM.
4) PEAK FIELD OCCURS AT Z = -0.15 CM.
5) B = 1% OF Break FOR Z = 10.4 CM. OR [illegible] FOR Z = [illegible] CM.



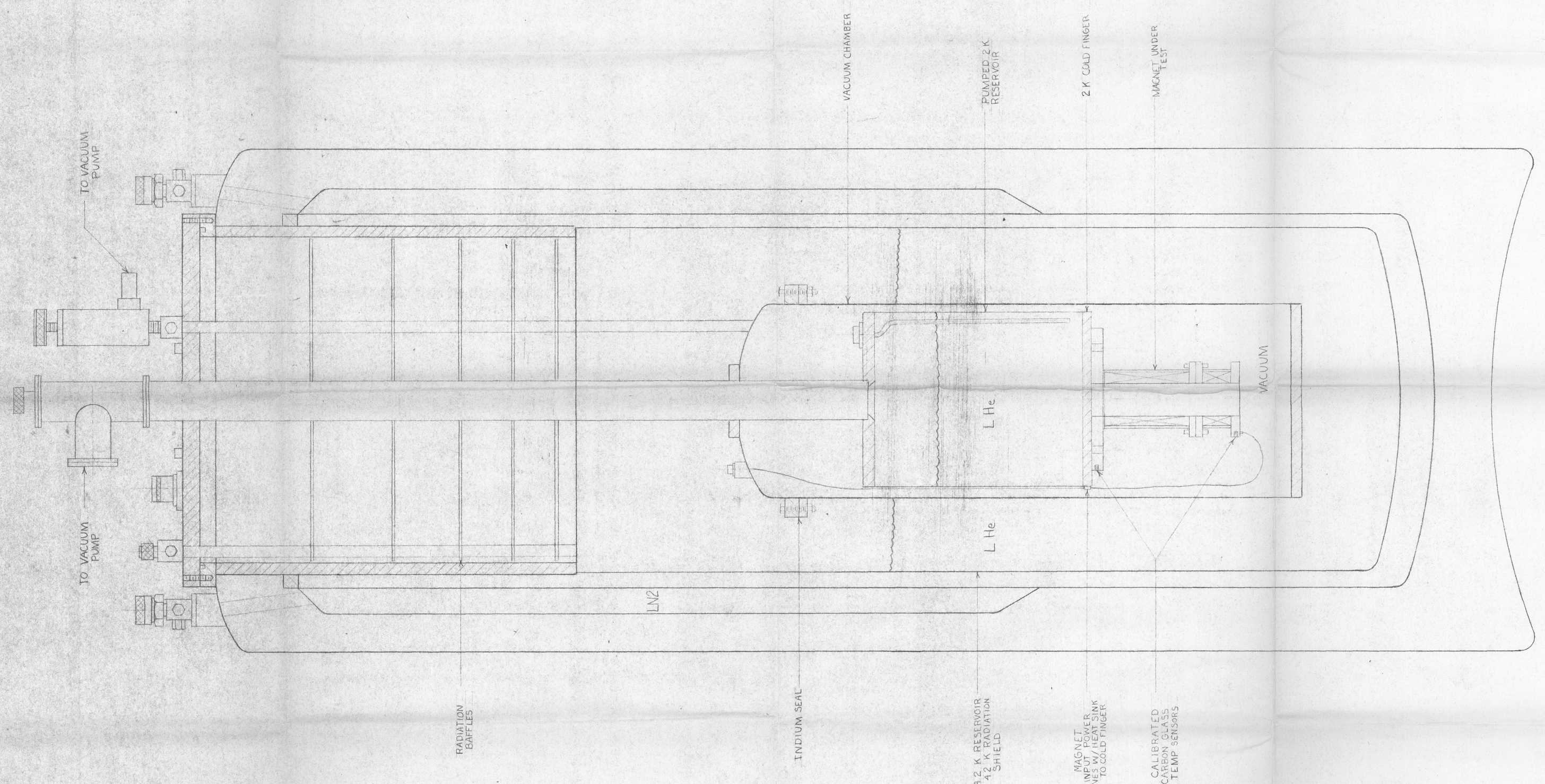


CRYOMAGNETICS INC.

SCALE 2" = 1"	APPROVED BY:	DRAWN BY: MTM
DATE 3-1-85		REVISED 3-1-85

NASA GODDARD SUPERCONDUCTING SOLENOID

DRAWING NUMBER: CM110-9

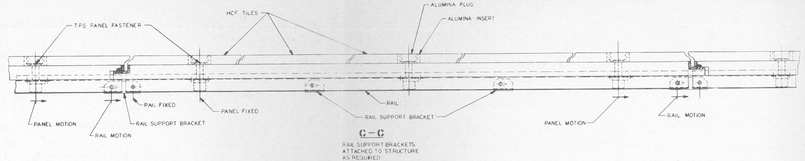


CRYOMAGNETICS, INC.

SCALE: N-S DATE: 1-26-85	APPROVED BY	DRAWN BY TDS

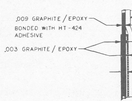
SC MAGNET TEST UNIT, 2°K & VACUUM

DRAWING NUMBER CMI-1016



G–G
RAIL SUPPORT BRACKETS ATTACHED TO STRUCTURE AS REQUIRED

TYPICAL SECTION OF HCF THICKNESS TRANSITION



VIEW G
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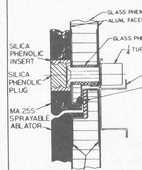
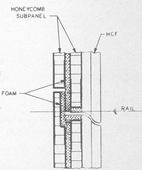


H–H
ALTERNATE VIEW SHOWING ABLATOR CONCEPT



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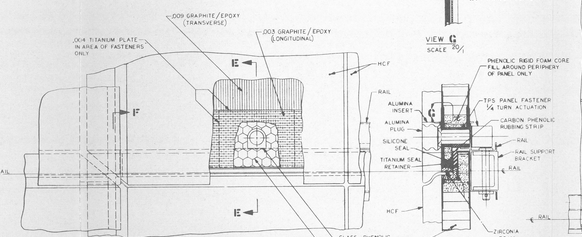
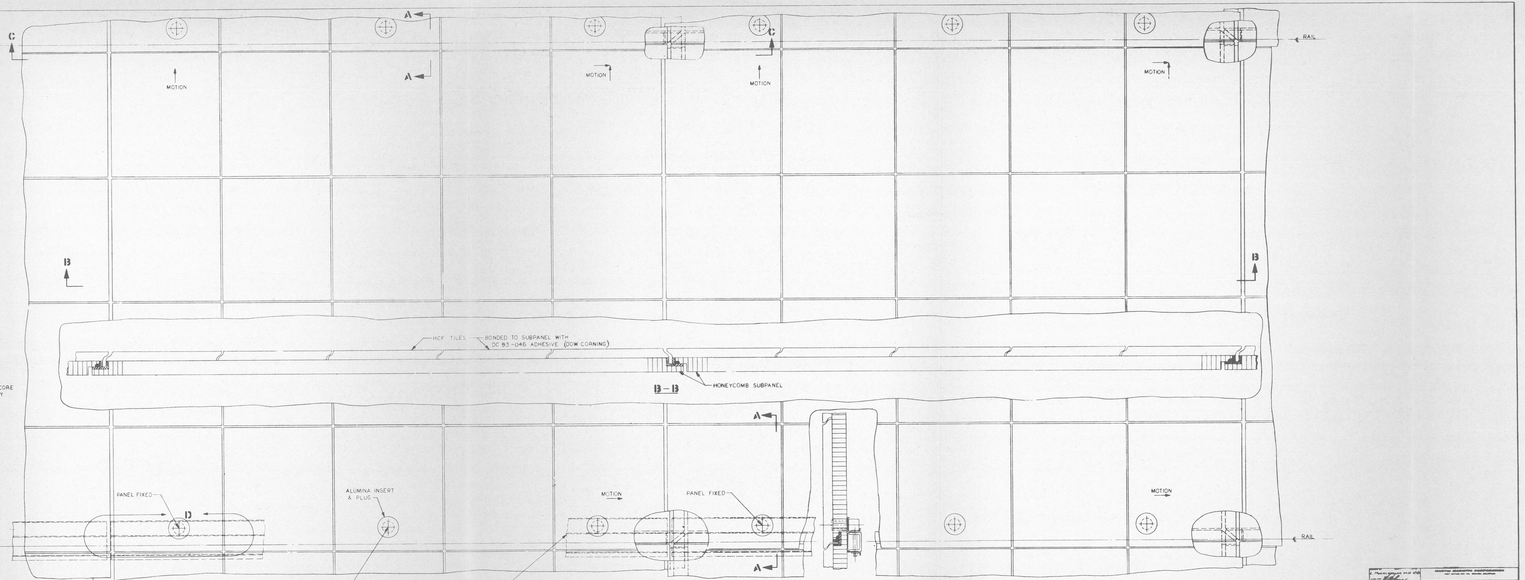
SCALE 3/1



VIEW D
SCALE 3/1

E–E
SCALE 3/1
SEE ALTERNATE SECT. H–H FOR ABLATOR CONCEPT



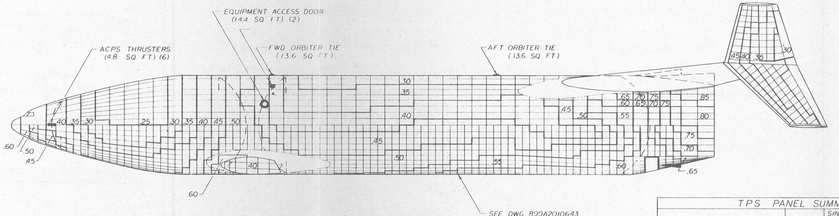
B–B

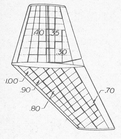
A–A

	TPS PANEL ARRIANGEMENT & DETAILS CONFIGURATION 20 B	
	94036	899 A 20808-47

BODY TPS GAP SUMMARY

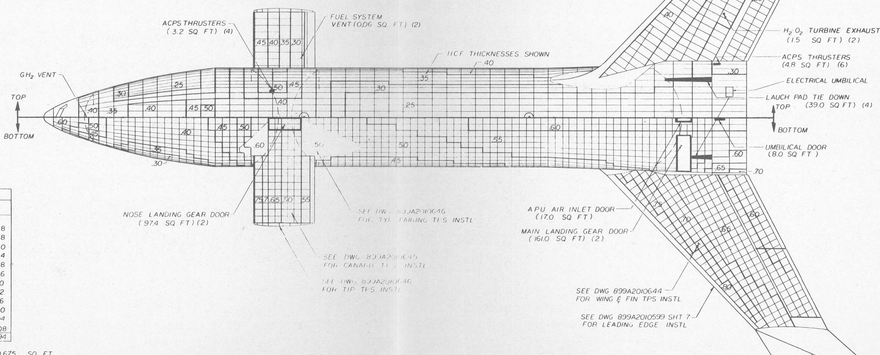
BODY LOCATION	TRANSVERSE ASSEMBLY	TRANSVERSE ASCENT MIN/MAX	TRANSVERSE ENTRY MIN/MAX	LONGITUDINAL ASSEMBLY	LONGITUDINAL ASCENT MIN/MAX	LONGITUDINAL ENTRY MIN/MAX
LO_2 TANK STA 1885						
POINT 1 (L-30)	.119 ±.030	.004/.064	0/.060	.137±.030	.061/.121	0/.060
POINT 2 (L-30)	.114 ±.030	.017/.077	0/.060	.137±.030	.060/.120	0/.060
POINT 3 (L-60)	.178 .030	.022/.082	0/.060	"	"	"
POINT 4 (L-60)	.186 ±.030	.012/.072	0/.060	.137±.030	.059/.119	0/.060
INTERTANK STA 2003						
POINT 1 (L-30)	.181 ±.030	0/.060	.124/.184	.036±.030	0/.060	0/.060
POINT 2 (L-30)	.150 ±.030	0/.060	.097/.157	.036±.030	0/.060	0/.060
POINT 3 (L+60)	.262 ±.030	0/.060	.201/.261	"	"	"
POINT 4 (L-60)	.156 ±.030	0/.060	.069/.129	.036±.030	0/.060	0/.060
LH_2 TANK STA 2163						
POINT 1 (L-30)	.176 ±.030	0/.060	.116/.176	.051±.030	0/.060	.024/.084
POINT 2 (L-30)	.136 ±.030	0/.060	.079/.139	.051±.030	0/.060	.040/.100
POINT 3 (L+60)	.234 ±.030	0/.060	.164/.224	"	"	"
POINT 4 (L-60)	.209 ±.030	0/.060	.131/.191	.051±.030	0/.060	0/.060
LH_2 TANK STA 3036						
POINT 1 (L-30)	.138 ±.030	0/.060	.066/.126	.051±.030	0/.060	.017/.077
POINT 2 (L-30)	.135 ±.030	0/.060	.077/.137	.051±.030	0/.060	.030/.090
POINT 3 (L-60)	.232 ±.030	0/.060	.154/.214	"	"	"
POINT 4 (L 60)	.355 .030	0/.060	.284/.344	.051±.030	0/.060	.033/.093
(GAP) →						





WING TPS GAP SUMMARY (CHORDWISE GAPS)

LOCATION	UPPER SURFACE ASSEMBLY	UPPER SURFACE MAX g_{TW} MIN/MAX	UPPER SURFACE MAX g_{TW} ENTRY MIN/MAX	LOWER SURFACE ASSEMBLY	LOWER SURFACE MAX g_{HW} MIN/MAX	LOWER SURFACE MAX g_{TW} MIN/MAX	LOWER SURFACE ENTRY MIN/MAX
WING ROOT	.113±.030	0/.060	.146/.206	0/.060	.122±.030	.190/.250	0/.060 .134/.194
RIB "2	.135±.030	.006/.066	.163/.224	0/.060	.122±.030	.207/.267	0/.060 .189/.249
RIB "4	.135±.030	.038/.098	.138/.198	0/.060	.101±.030	.181/.241	0/.060 .167/.227
OUTBD ELEVON ACTUATOR	.126±.030	.023/.083	.115/.175	0/.060	.084±.030	.148/.208	0/.060 .147/.207
WING TIP	.139±.030	.037/.097	.120/.180	0/.060	.072±.030	.152/.212	0/.060 .156/.216
(GAP) →							



TPS PANEL SUMMARY

LOCATION	FLAT	SINGLE CURVE	DOUBLE CURVE	TOTAL
DORSAL FIN OUTBOARD SURFACE	—	118	—	118
" INBOARD SURFACE	—	118	—	118
VENTRAL FIN OUTBOARD SURFACE	—	120	—	120
" INBOARD SURFACE	—	114	—	114
WING LOWER SURFACE	536	92	—	628
" UPPER SURFACE	54	332	—	386
CANARD LOWER SURFACE	—	180	—	180
" UPPER SURFACE	—	92	—	92
BODY NOSE SURFACE			36	36
" FOREBODY SURFACE		28	562	590
" CONSTANT SECT SURFACE	92	1266	46	1404
" AFT SECT SURFACE	316	70	522	908
TOTAL	998	2530	1166	4694

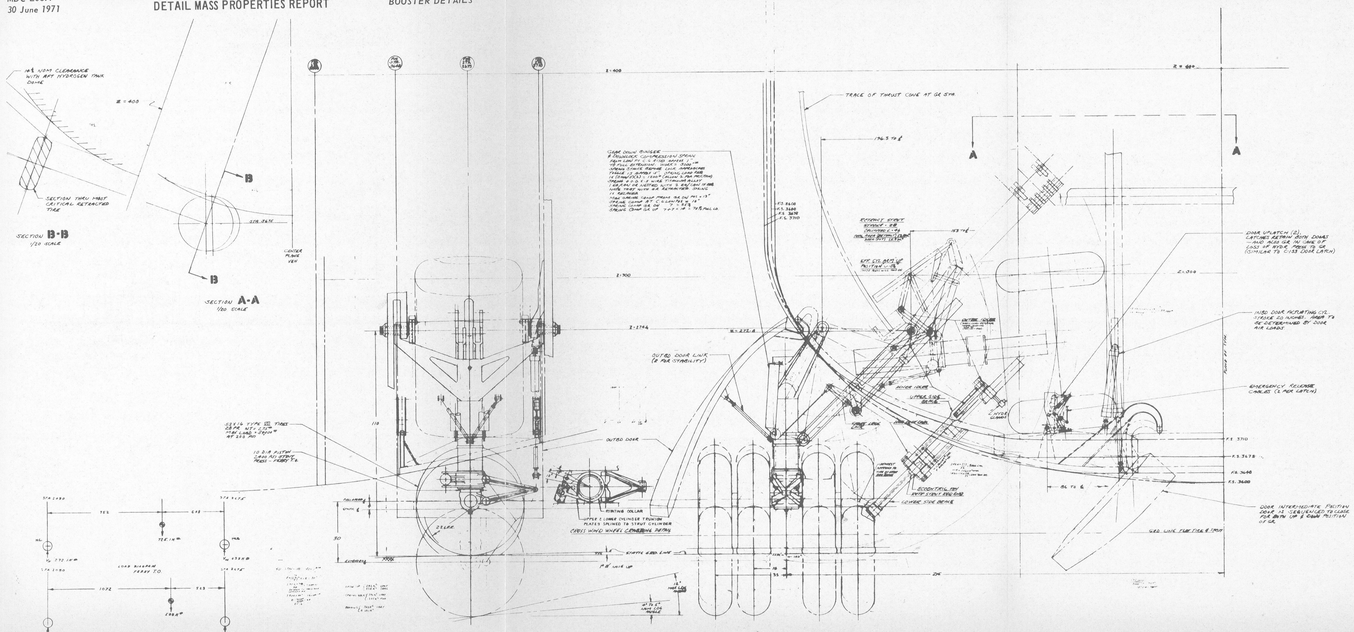
TOTAL SURFACE AREA COVERED BY HCF	39,675	SQ FT
FILLETS AND CREW COMPARTMENT	1,188	SQ FT
TPS PANEL AREA	38,487	SQ FT
AVERAGE PANEL AREA	8.2	SQ FT

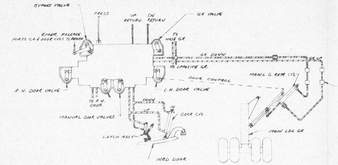
DESIGN REQUIREMENTS

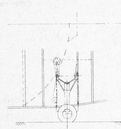
A. FUNCTION
1. SUSTAIN TEMPERATURES
   a. PREVENT ENTRY OF HOT BOUNDARY LAYER GASES.
   b. PREVENT RADIATION AND CONVECTION THROUGH THE GAPS.
2. BE IMPERVIOUS TO MOISTURE.
3. RESIST HAIL, SALT AIR, FUNGI, DUST.
4. SUSTAIN AIRLOADS AND ACOUSTIC FLUTTER AND OTHER VIBRATIONAL LOADS WHILE MAINTAINING STRAIN COMPATIBILITY BETWEEN SUBSTRATE PANEL AND HCF.
5. SHED AIRFLOW-NO EXPOSED EDGES TO FACE FLOW.
6. —
   RAIN.
7. ACCOMMODATE CONTRACTION AND EXPANSION OF STRUCTURE AND TPS WITH MINIMUM GAPS.
8. ACCOMODATE OR AVOID WEAR OF RUBBING SURFACES.
9. MAINTAIN AERODYNAMIC SHAPE.
10. CONTROL AIR LEAKAGE BETWEEN PANELS
    a. PURGE
    b. VENTING

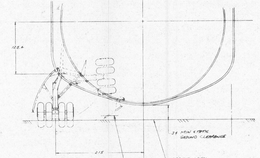
B. DESIGN IMPLEMENTATION
1. ACCOMODATE ANTENNAS AND PENETRATIONS.
2. STANDARDIZE PANEL SIZES, CONFIGURATIONS AND ATTACHMENTS AS MUCH AS POSSIBLE.
3. SEAL DOORS
   a. TPS MUST NOT BIND DOORS AFTER ENTRY
4. LIMITED SIZE AND WEIGHT FOR EASY HANDLING.
5. MUST BE INTERCHANGEABLE.
6. PANELS MUST BE QUICKLY REMOVEABLE
   a. NO SEQUENTIAL ORDER OF INSTALLATION
7. SEALS MUST NOT BE EASILY DAMAGED DURING REMOVAL AND INSTALLATION
8. ACCOMODATE REPLACEMENT OF HCF WITH ABLATORS.

MARTIN MARIETTA CORPORATION
BOOSTER OVERALL TPS ASSEMBLY CONFIGURATION 20A
04336 899A2010642









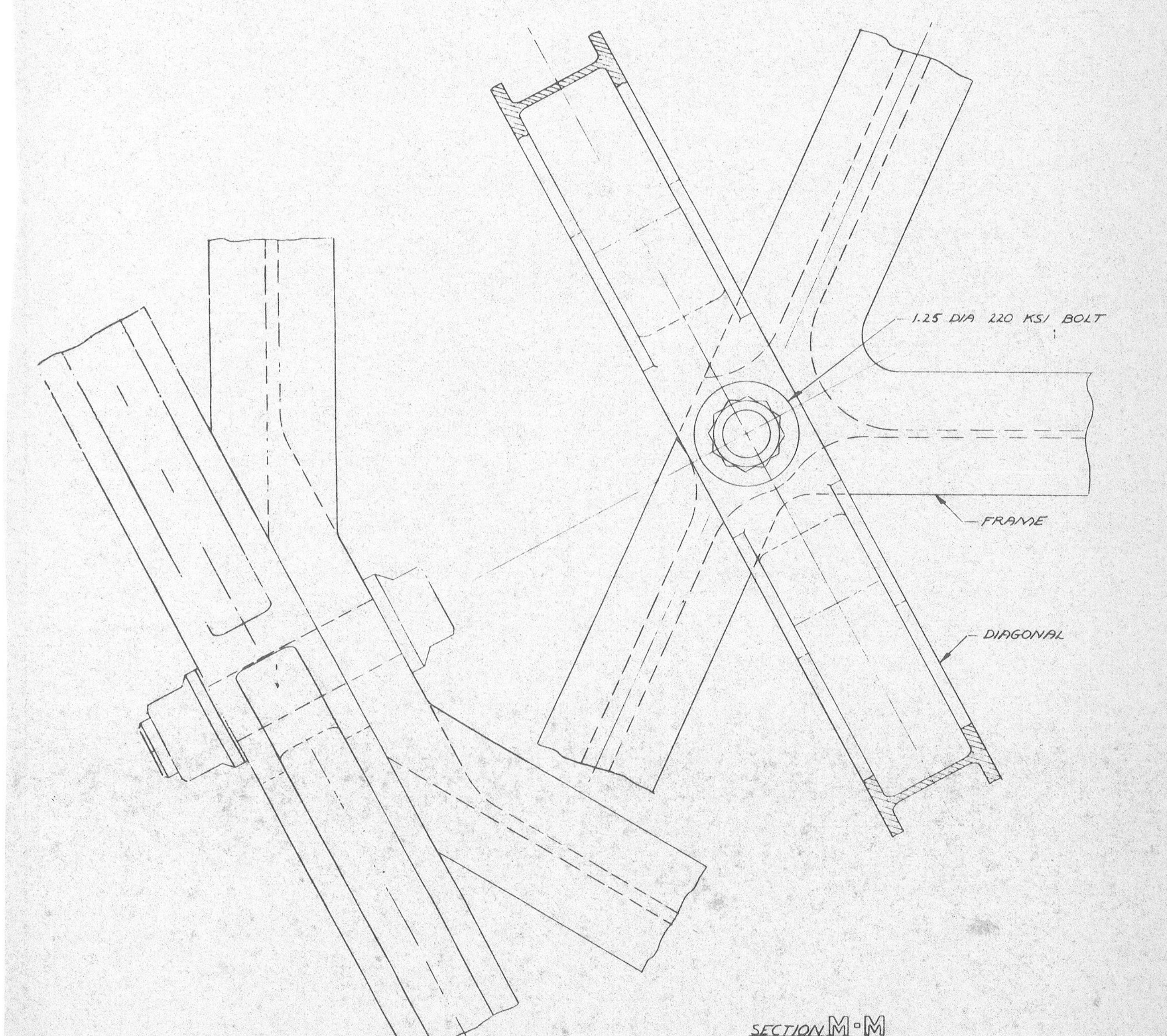
GENERAL NOTES

. FOR GEAR DESIGN LOADS SEE MDC E0376 PART III BOOSTER AIRFRAME

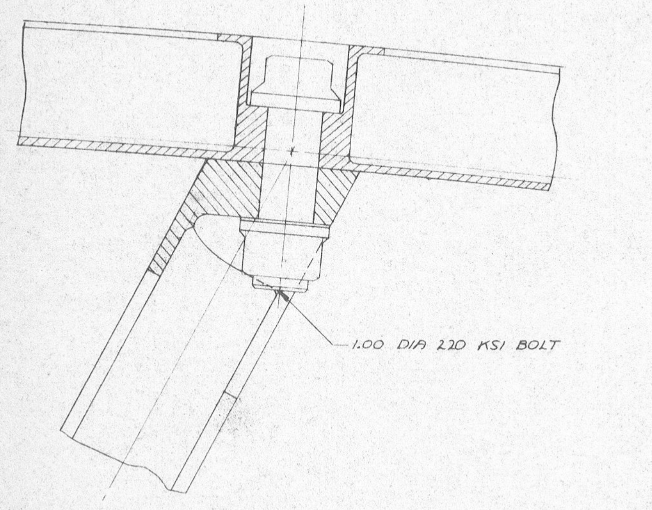
REVISIONS			
LTR	DESCRIPTION	CHANGE AUTH NO.	DATE
A	PER RELEASED NOTICE		

LAYOUT-INSTALLATION, MAIN LANDING GEAR

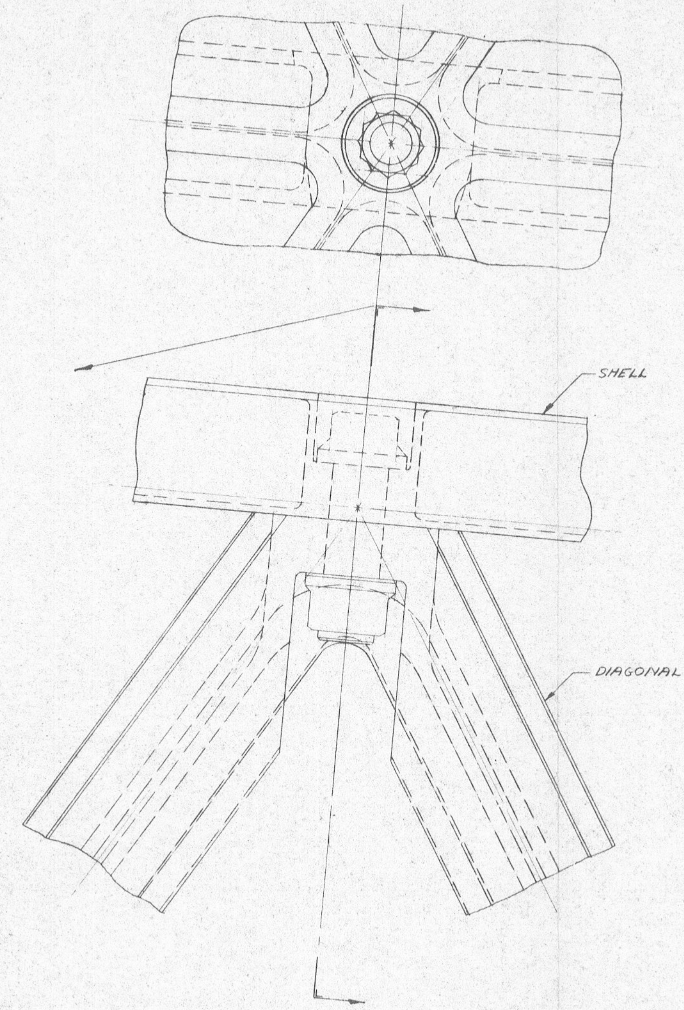
256-20-0010

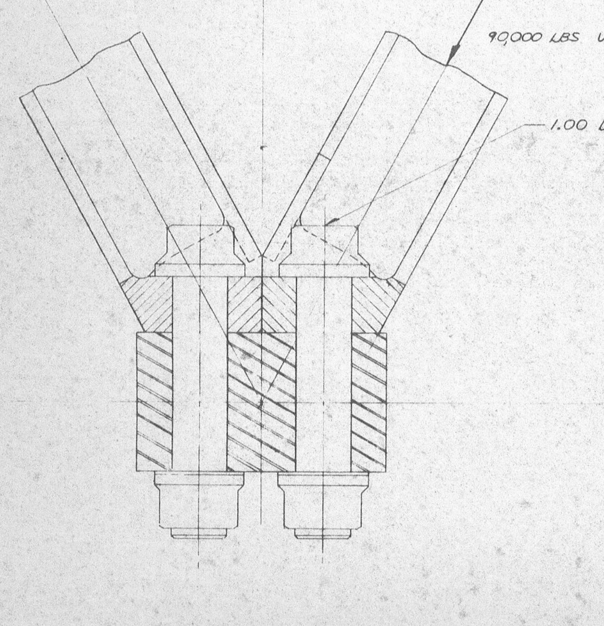


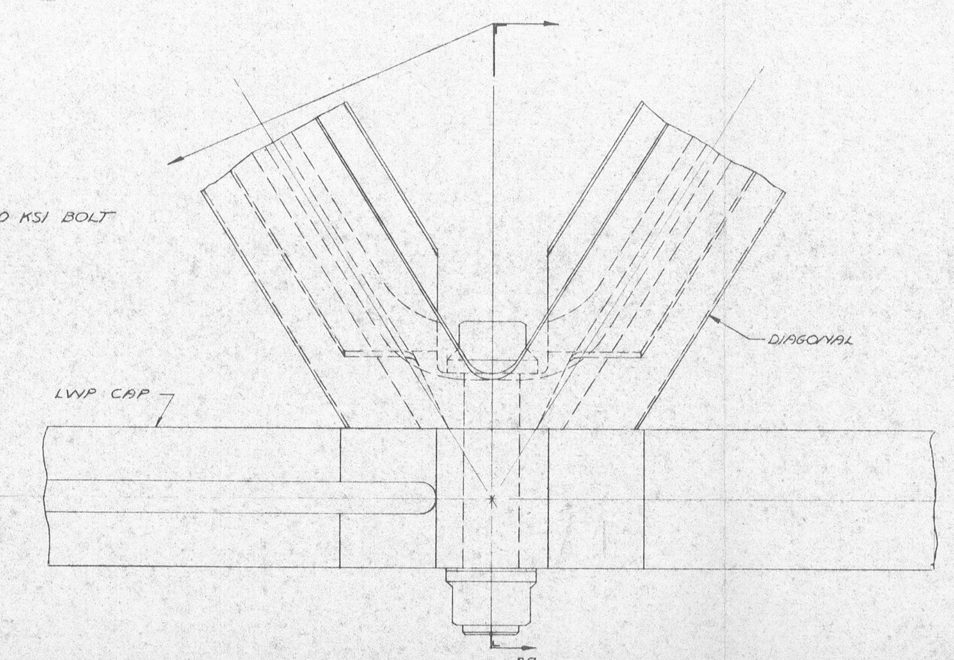
SECTION M-M
TYP DIAG TO FRAME ATTACH
FULL SIZE



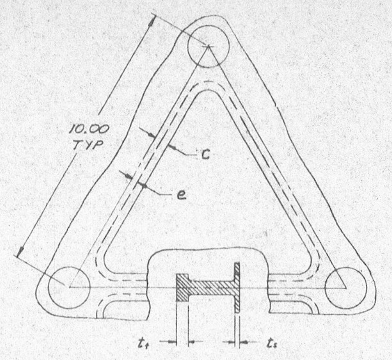
SECTION L-L
TYP DIAG TO SHELL ATTACH
FULL SIZE





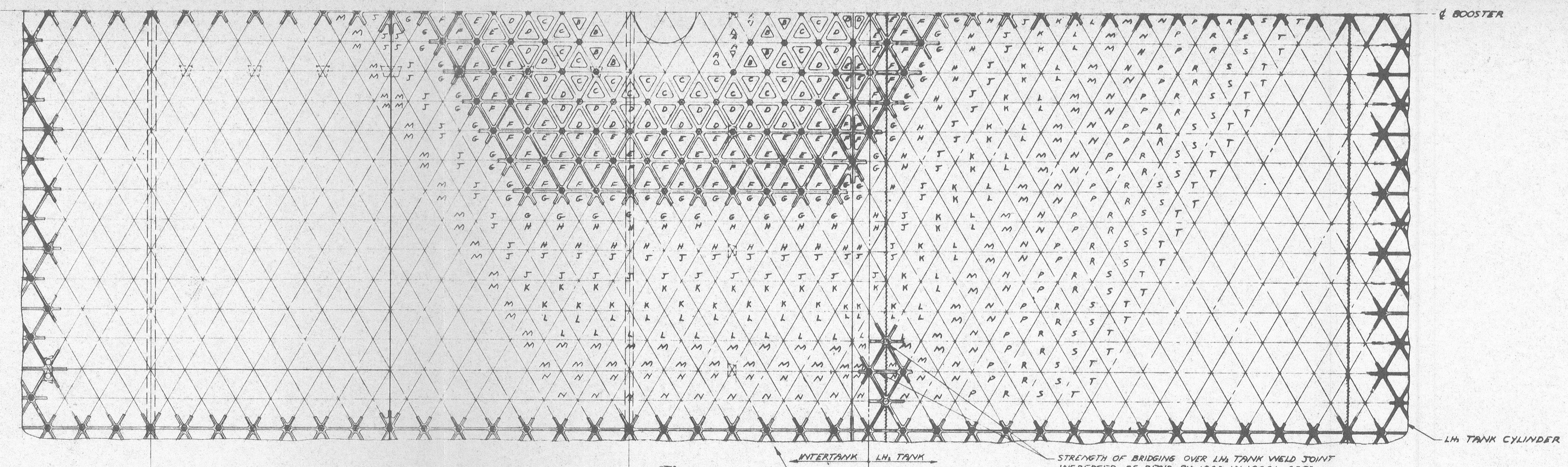


VIEW K
TYP DIAG TO LVVP CAP ATTACH
FULL SIZE

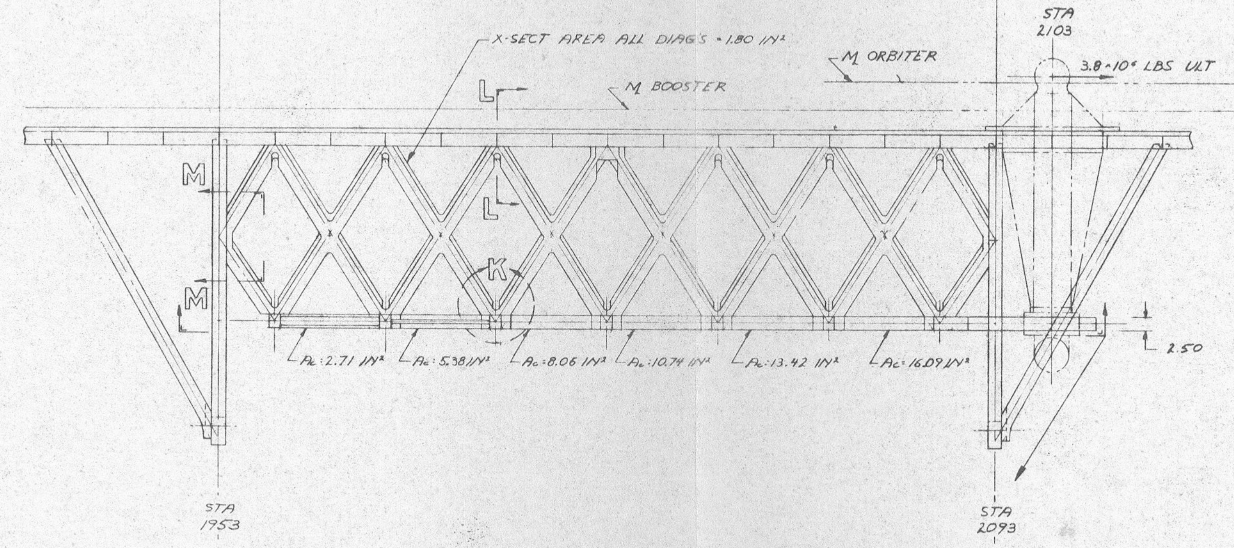


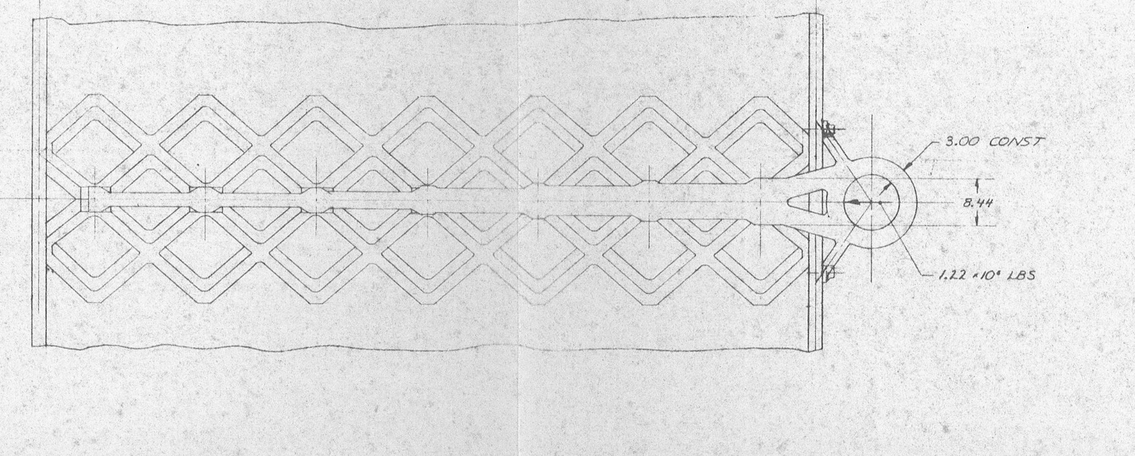
POCKET DIMS @ FWD ORBITER ATTACH					
POCKET	LOAD LBS/IN	t_s	e	C	t_f
A	61,400	.378	2.350	*	*
B	48,000	.295	1.680	*	*
C	37,700	.240	1.250	*	*
D	27,800	.185	.850	*	*
E	22,500	.165	.650	*	*
F	19,500	.164	.423	.500	.710
G	16,900	.160	.298	.500	.527
H	15,300	.157	.243	.500	.435
J	14,000	.154	.197	.500	.361
K	13,000	.152	.164	.450	.344
L	12,200	.150	.140	.400	.335
M	11,500	.148	.118	.350	.336
N	10,800	.145	.100	.300	.347
P	10,400	.144	.089	.300	.317
R	9,900	.142	.078	.300	.283
S	9,400	.140	.066	.300	.255
T	9,000	.139	.058	.300	.230

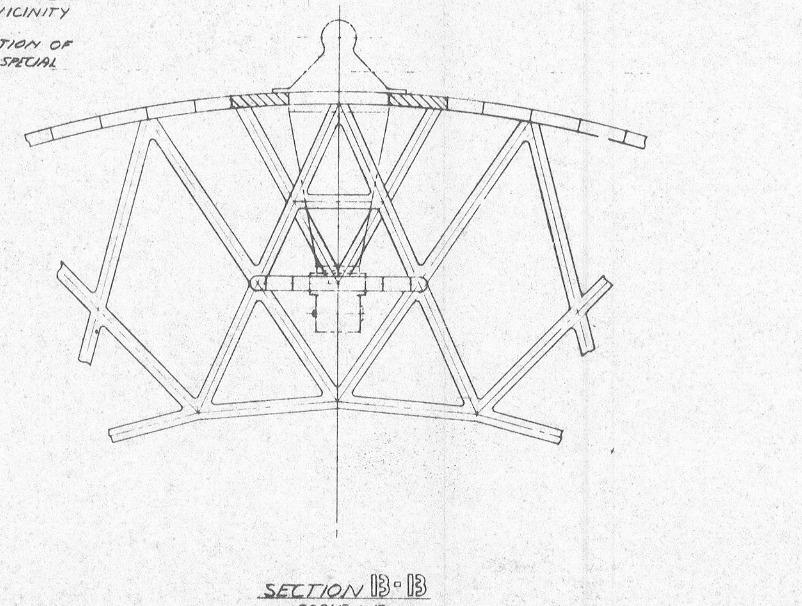
*UNFLANGED GRID



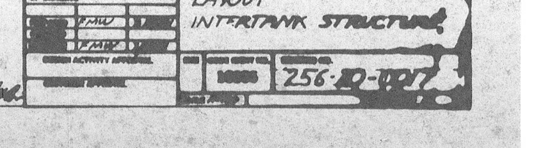
VIEW LOOKING DOWN ON FLAT PATTERN OF SHELL SHOWING DISTRIBUTION OF MATERIAL IN VICINITY OF FWD ORBITER ATTACH
THIS DISTRIBUTION INDICATES THAT RELOCATION OF ATTACH APPROX 100 IN FWD MAY KEEP SPECIAL MACHINING OUT OF TANK AREAS

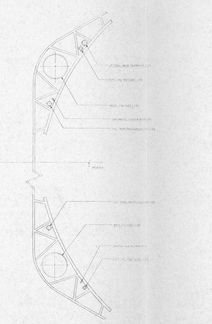


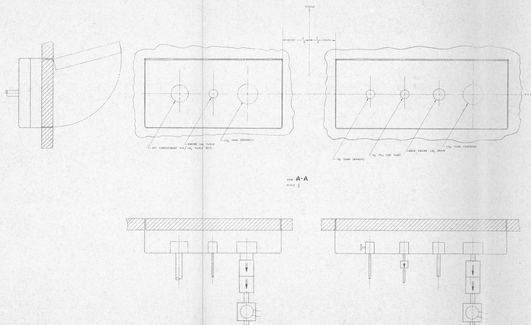


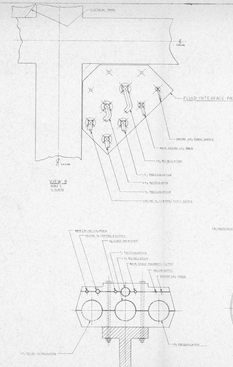


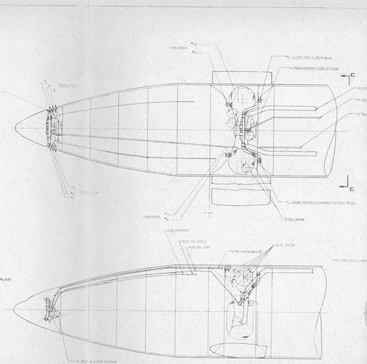
SECTION B-B
SCALE 1:10

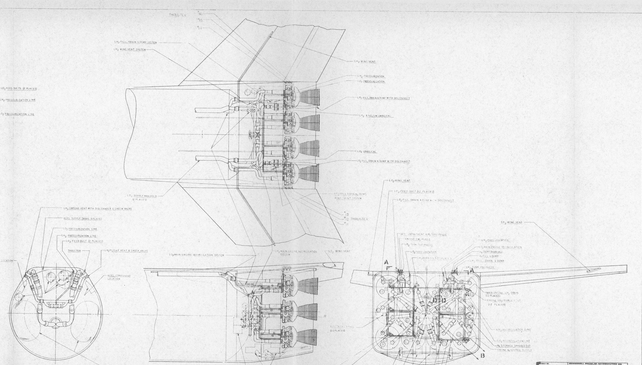













CONTRACT NO.
ORIGINAL DATE OF DRAWING
PREPARED ROOK 6-4-71
CHECKED
ENGINEER 6/8/71
DESIGN ACTIVITY APPROVAL D.F. GREENE 6/8/71
CUSTOMER APPROVAL
MCDONNELL DOUGLAS ASTRONAUTICS CO.
WESTERN DIVISION
HUNTINGTON BEACH, CALIFORNIA
LAYOUT-SCHEMATIC,
BOOSTER HYDRAULIC SYSTEM
SIZE J
CODE IDENT NO. 18355
DRAWING NO. 256-20-0009
REV. A. 6/8/1
SCALE ——
SHEET 1 OF 1


LEGEND
NOTES -
1. COMPONENT IDENTIFICATION NUMBERS ARE IDENTIFIED WITH LAST TWO DIGITS OF THIS DRAWING NUMBER 29-1, -2 ... ETC.
2. SYSTEM COOLANT IS FREON 21
3. AGE COOLANT IS ETHYLENE GLYCOL
4. PIPING CODE EXAMPLE -
40 - S - 020
WALL THICKNESS IN THOUSANDTHS OF INCH
MATERIAL
S - STAINLESS STEEL
T - TITANIUM
A - ALUMINUM
F - FIBERGLASS
OUTSIDE DIAMETER IN 1/16 OF INCH
5. THE ECLS DISPLAYS ARE CODED WITH THEIR TRANSDUCERS IN THE SCHEMATIC. CABIN TEMPERATURE AND PRESSURE DISPLAYS, FOR EXAMPLE, ARE CODED Tc AND Pc AND THE TRANSDUCERS IN THE CABIN AREA OF THE SCHEMATIC ARE CODED THE SAME.
6. THIS SCHEMATIC PERTAINS TO THE BOOSTER CONFIGURATION 20B
ECLS DISPLAYS & CONTROLS, BOOSTER
PRESSURES
TEMPERATURES
COOLANT LOOPS
AIR CYCLES
HYDROGEN COOLING
CABIN TEMP
WINDSHIELD RAIN REMOVAL
WINDSHIELD RAIN REMOVAL SUPPLY SYSTEM 29-1
FORWARD AREA
INTERTANK AREA
AFT AREA
SCHEMATIC - COCKPIT AND AVIONICS ECLSS BOOSTER
CONTRACT NO.
ORIGINAL DATE OF DRAWING
PREPARED 5-19-71
CHECKED
ENGINEER 6-8-71
DESIGN ACTIVITY APPROVAL
D.F. GREENE, 6-10-71
CUSTOMER APPROVAL
SIZE J
CODE IDENT NO. 18355
DRAWING NO. 256-20-0029
SCALE -
SHEET 1 OF 1